System Design (System Engineering) ... the process

follows engineering process: successively break down problems into smaller ones, then solve.
- result is a system built up from a set of subsystems
- repersented in a block diagram (and other ways)
- may also help in devloping budget information

Input = <u>Requirements Specification</u> (*What* is the problem to be solved?)

Output = <u>System Specification</u> (*How* will the problem be solved?)

System Design consists of…
- Conceptualization - Synthesis - Analysis
- Block diagram(s)

<u>Conceptualization (its about creativity)</u>

- consider many (or at least several?) alternatives
- conflicting needs - quick solution vs innovative solution
- *major impediment*: doubt that a solution exists

two sources of concepts...
- "external": existing ideas / concepts that meet needs or are close (interpolate, extrapolate)
  - "linear thinking" (economical, reliable - most commonly used)
  - proven concept - reduces development time, lower cost, lower risk - but less innovative
- "internal": new idea or conept - never done before
  - "lateral thinking"
  - original concept - more effort to develop, therefore more expensive, also more risk - more innovative and maybe more competitive edge

New concepts - result of "creative thinking"
- go through all known scientific principles and try to think of a way to apply to problem
  - can generate numerous new concepts
  - do better with more experience, knowledge
  - may produce many ideas that are not immediately useable

<u>Synthesis ("bringing structure to the initial concept")</u>

- Block diagram starts here - tool for communicating as an aid to thinking / creating
  - details increases as design progresses

- As in conceptualization, can take 2 approaches here even within a concept:
  - extrapolate an existing solution (linear thinking)
    - economical, reliable, faster
  - synthesize a completely new solution (lateral thinking)
    - more effort, risk but chance of more innovative result
- May be forced one way or the other by circumstance
  - limited time or resources
  - completely new problem

Analysis ("Tests" or analyzes the potential solution to see if it meets the needs or how well it meets the needs)
May utilize tools such as simulation, testing, prototyping

The iterative cycle of synthesis and analysis
- design improves with each iteration as problems are solved by re-synthesizing
- analysis becomes more detailed and rigorous as design approaches a final solution
  - may start off with mental analysis and progress to simulation or testing
- potential solution may be abandoned or "repaired" at any point
  - how far back we go to "repair" is also a judgment call
    - go back to first structure and modify
    - new structure
    - new concept
  - with experience and knowledge, poor choices can often be abandoned quickly
  - effectively increase the "search space" using creative thinking

Output from this iterative process is usually a Block Diagram with a detailed description of the inputs and outputs for each block as well as the whole, and a accompanying functional descriptions.

Block Diagrams (picture that captures the resultant design)

- Blocks should have a single purpose
  - Such that they can be completed by a single person
- Contain a single technology (e.g. digital vs analog)
- Common functions grouped in one block (e.g. power, clock)
- Shold be defined to simplify interfaces between them
  - Avoid feedback loops between blocks
- Interface signal parameters are often included on diagram
  - e.g. levels, frequency, SNR, impedance, timing info …
- micro's comonly defined in separate block in hardware block diagram
  - software usually in a sperate block diagram

Thorough annotation important
- Labels for blocks and interface signals

System Specification

Consists of Block Diagram(s) and Functional Description(s)

System Specification (outline)
- o The Concept
- o Block Diagram
- o Functional Description
    - o of the Blocks
    - o of the system
- o Analysis (and test info)

Serves as input to … Detailed Design process.

Should contain:
- o Enough detial to allow for revisions if necessary
- o Reference for future
- o Information for testing process
- o Information for Marketing purposes